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Title
The Use Of PV To Replace Typical Skylight And Its Energy Generation For Cooling And Lighting In Malaysian Atria

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Atrium is an architectural feature often found in commercial buildings in Malaysia and the top-lit type is the most common. Besides its architectural value as a spatial connector, the introduction of translucent material as its roof envelope could turn it into a large daylight catcher. Its ability to serve as a media to allow entry of sun into the building means that it could bring in both daylight as well as excessive solar heat. For buildings in the tropical climate zone such as Malaysia, maximizing solar gain is most undesirable, as this will increase the indoor temperature and consequently unnecessary amount of energy is needed to cool back down the internal spaces to an acceptable thermal comfort level. A good energy efficient strategy is to channel the intense solar heat away from the interior, and capture its energy resource. Photovoltaic (PV) panel or commonly known as solar panel converts solar energy into electrical energy. Its productivity depends largely on its solar exposure hours, the placement of its panels in terms of the slope angle and orientation to the sun. When applied in buildings, PV is referred to as Building Integrated Photovoltaic (BIPV). BIPV system is a relatively expensive investment, thus its application has to be carefully considered to achieve optimization. Theoretically replacement of the conventional glass skylight with PV panels, improves the energy efficiency of the atrium through electrical energy production of the PV panels. It offsets the additional energy required to cool down the space due to solar heat gain. This thesis was set up to achieve three main objectives – firstly was to determine the amount of energy production through a modeling of basic BIPV (Building Integrated Photovoltaic) configurations for installation in atria. Secondly was to assess if the power generated is more than the additional cooling load required to compensate (off-set) the increase of indoor temperature leading from the solar heat gain due to the change in the skylight material. The final objective was to determine the best roof model and orientation to achieve optimum BIPV application. Three roof form types (hipped, gable and sawtooth) were shortlisted due to their suitable application with opaque PV panels that by far, its power productivity is better than the thin film type. To give a fair comparison, the roof surface area of all the three types were made similar (2325 sq m), and 10% of the surface area was of glazing, so as to provide minimum acceptable indoor illumination of 350 lux. Dependence variables were roof surface inclination (30º), PV type (Kyocera), PV surface area (2250 sq m), orientations (N, NE, E, SE, S, SW, W, NW), day of the year (March 28, the clearest sky, and March 7, the cloudiest). The independence variable was the roof form. The extra energy required was determined by subtracting the U-value of the conventional skylight glazing material from the U-value of the PV panel, and multiply by the total surface area of the PV used. ECOTECT environmental software was later used to determine the power productivity of BIPV applications for the respective roof form types in eight (8) main orientations. The results indicate that the maximum PV generation for all the roof models are achieved at N270° orientation. The highest energy generator was the Gable type, with the highest power productivity recorded at five out of the eight orientations (N0°, N45°, N90°, N135° and N180°). The Sawtooth type generated the highest power productivity at three orientations (N225°, N270° and N315°), however its production is the least if oriented at N90° by 18.7%. In conclusion, the study identified the Gable model to be the most flexible for BIPV application purposes where it offers highest average power productivity of 394,059.7 kWh, in all eight orientations. The average power production from the BIPV application was 383,621kWh, which is more than the additional power needed to normalize the solar heat gain due to replacement of the roof material by 200%.